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## ELECTRICAL SCIENCE.

## Alternating-Current Electro-Motors.

TWO inventions that will greatly modify and improve the conditions of electrical distribution have been for some years past the subject of much thought and experiment among electricians. They are the secondary battery and the alternating-current electro-motor. To-day there are secondary batteries in use, and there are alternating-current motors, that will run with some degree of success; but improvement is necessary in order that they may be adapted to extensive operations, and it is only a matter of time when these improvements will be made.

The Tesla electric motor, of which a brief description has appeared in this journal, seems the most successful attempt that has been made for the distribution of power by alternating currents. The difficulties in the way of such a motor are these: it must start with the maximum turning effort; when it attains its proper speed, it must regulate itself for varying loads; and it must be made to work under constantly changing load; and all these requirements are difficult to fulfil in the same machine. In one form of motor Mr. Tesla obtains synchronism between the revolutions of the armature and the reversals of the feeding dynamo; that is, it regulates itself. This form has little or no turning effort at the start. In another type a considerable turning effort is obtained, but there is no regulation. By combining the two characteristics, a motor is produced that will start, and when it arrives at its proper speed will regulate, itself. This seems the most plausible plan that has been yet suggested for the purpose. It will be remembered that the motor presents the peculiarity of having no connection between the armature-coils and the external circuit, currents being induced in the former by the alternations of the field-currents, and so is the simplest mechanical and electrical arrangement possible.

In a paper read before the Institute of Electrical Engineers, Mr. Tesla explained the system, but unfortunately gave no data as to the efficiency, output, etc., of the motors. Such data will probably be forthcoming, for such a promising invention cannot but be given an exhaustive trial; and it is to be hoped, that, when the data does appear, it will be of a kind to at once allow an opinion to be formed on the value of the *principle* as well as of the particular machine tested.

**ELECTRICAL WELDING.**—Among the various uses to which electricity has been applied, the welding of metals is one of the latest. Two distinct processes are now in use,—that of Prof. Elihu Thomson, and that of M. Bernados. In Thomson's method a very heavy current is sent between the metals to be joined (which are held firmly against one another), heating the junction until it is to a welding heat. The junction is, of course, the point of greatest resistance, and therefore the heat is mainly concentrated there. The currents are obtained from the secondary of an induction-coil supplied with alternating currents: this secondary is of very low resistance, and is secured to the pieces to be welded by massive clamps. It will be seen that this method is especially applicable to the welding of tubes, rods, wires, etc. The process of M. Bernados is very different. In it the heat of the electric arc is used, the junction to be welded being made one of the poles. Current is obtained from accumulators especially built to resist the ill effects of a heavy discharge rate, and the arc is directed to the proper place by a rod of carbon held in the hand in a suitable holder. The method of operation consists in placing the pieces to be welded on a heavy iron slab, which serves the double purpose of supporting and carrying the current to the plate, meeting the edges of the pieces, then putting the scraps of iron (if iron is to be welded) on the junction, and melting the whole together. For welding steel or wrought iron, a mixture of sand and lime is used as a flux; when copper is one of the metals used, borax is employed. Mr. Ryves, who has investigated the process, and has lately read a paper upon it before the Society of Telegraph Engineers and Electricians, states that in nearly every case the metal was badly burnt and spoiled by the excessive heat. M. Bernados has also lately made a number of experiments on the working of various metals and the production of alloys in electrical furnaces. As far as welding goes, it is very probable that the electric arc can be regulated to give the required heat without burning the

metal. Of the two welding processes, that of Professor Thomson is surer and more easily controlled; that of M. Bernados is more widely applicable.

**DIFFERENCE OF POTENTIAL BETWEEN METALS IN SOLUTIONS OF DIFFERENT STRENGTHS.**—The following table is not without interest as showing the variation in the electro-motive force of a cell, which might occur when the solution changed in strength from evaporation or other causes. It is unfortunate that potassium cyanide was chosen as the electrolyte, instead of some more commonly used substance. One curious result will be noticed: zinc and copper have a potential difference from a carbon electrode which is at first considerable; but, as the strength of the solution increases, the two substances get nearer together in the table. Carbon was invariably used as the positive element. The differences of potential are in volts.

Strength.....	.006	.025	.25	.5	1.	2.	5.16
Zinc.....	.925	1.130	1.350	1.395	1.450	1.520	1.615
Copper.....	.250	.390	1.215	1.270	1.295	1.425	1.535
Brass. ....	.290	.580	1.130	1.210	1.295	1.400	1.460
Platinoid. ...	.435	.535	.825	.900	.945	1.030	1.185
German silver....	.360	.500	.860	.920	.910	1.050	1.180
Silver.....	—	.390	.655	.695	.760	.845	.970
Lead. ....	.460	.440	.590	.585	.610	.640	.700
Iron.....	.230	.300	.539	.450	.430	.470	.455

**EXPANSION GALVANOMETER.**—Prof. W. E. Geyer and Mr. W. H. Bristor have invented a new and ingenious galvanometer. In thermostats and in the balance-wheels of chronometers the difference in the rate of expansion of two metals is taken advantage of to cause a movement, which in the one case closes or opens an electric circuit, in the other compensates for the linear expansion of the wheel. Two strips of different metals are usually fastened side by side; and, as one of them expands faster than the other, it causes the system to bend one way or the other. As an electric current causes heating, and as the amount of heating is proportional to the square of the current, some such arrangement as the above might be used for measuring current strength. The disadvantage with the ordinary form would be that the instrument would have to be adjusted for every change of temperature. To avoid this, Messrs. Geyer and Bristor use a broad strip and a wire of german silver fastened together; one end fixed, the other attached to a registering arrangement. The current passes through these strips in series. Now, while for ordinary changes of temperature both the strip and the wire expand alike, yet, when a current is sent through them, the wire, having the smaller section and less radiating surface, heats the faster, and its greater expansion deflects the needle. By a suitable gearing the deflections are made directly proportional to the currents. This instrument can measure both alternating and direct currents. It is simple, and should be unaffected by the presence of magnets.

**THE WATER-JET TELEPHONE-TRANSMITTER.**—This transmitter has been recently exhibited in England, where it has attracted attention, both by its novelty, and its excellent performance as a long-distance transmitter. The following is an abstract from a lecture recently delivered by Mr. G. W. de Tunzeemann: "The jet-transmitter consists of a small jet of water, acidulated to render it a conductor, falling upon two electrodes, consisting respectively of a platinum wire, and a platinum ring concentric with the wire, and separated from it by a ring of glass or ebonite. The connection between the electrodes is formed by the nappe of the jet; and, when the jet is thrown into vibration by the sound of the voice, the variation of resistance between the electrodes causes it to act as a transmitter of great delicacy. This delicacy is so great that the voice of a person speaking in an ordinary tone at a distance of fifteen or twenty feet from the instrument is reproduced in a distant telephone with the most perfect distinctness."